REMARKS

Notice of Paper Submission Under 37 C.F.R. 1.34(a)

The present paper is submitted under 37 CFR 1.34(a) and MPEP 405 by the undersigned Applicant's representative who is not the attorney of record in the present application. All communications regarding the present application should continue to be directed to the attorney of record, Ivan S. Kavrukov, Cooper & Dunham LLP, 1155 Avenue of the Americas, New York, NY 10036.

Correction Regarding Drawing Submission Date

Applicant respectfully points out a typographical error in Examiner's Office Action Summary (PTO-326) incorrectly indicating, in item #10, that the accepted drawings were filed on "21 February 2002". However, it is Applicant's understanding that the accepted drawings were actually part of the application as originally filed on **February 12, 2001**.

Election Affirmed

Applicant affirms the provisional election made telephonically on October 24, 2002 without traverse to prosecute Claims 1-18 of the instant application.

Abstract

The Examiner objected to the Abstract as being too long. The Abstract has been revised such that the number of words has been reduced from 238 to 148. A minor spelling error has also been corrected ("perform" changed to "preform").

REJECTION UNDER 35 U.S.C. 112

The Examiner objected to Claim 1 by virtue of two instances of the phrase "adapted to". Claim 1 has been amended to recite, in place of each instance of "adapted to connect," the phrase "for connecting" which is believed to achieve the required correction.

REJECTIONS UNDER 35 U.S.C. 103(a)

The Office Action rejected Claims 1-18 under 35 U.S.C. 103(a) as being unpatentable over DiGiovanni et. al. (U.S. 5,802,236), the principal reference, in view of Van Der Tol (U.S. 5,418,867), the secondary reference. (In view of the subsequent Office Action text, it is believed that the first line of Paragraph 10 of the Office Action was intended to read "Claims 1-18" rather than "Claims 1-8").

Claim 1

Claim 1 has been amended to clarify that the first optical fiber is "a microstructured optical fiber" having a first cross-sectional material pattern that is "a void pattern." The Office Action indicates that the primary reference, DiGiovanni, discloses a microstructured optical fiber (MOF). However, no teaching or suggestion could be found in DiGiovanni of a first MOF (*i.e.*, the "first optical fiber") being used along the same optical signal path as either (a) a standard solid-core optical fiber (SOF), or (b) a second MOF having different properties (*i.e.*, the "second optical fiber"), as required by Claim 1. As understood, DiGiovanni does not teach or suggest a need, desire, or goal of using an MOF in combination with other types of fibers, whether they be SOFs or differently-structured MOFs. Accordingly, as understood, DiGiovanni is devoid of any motivation for developing an optical device according to Claim 1 as amended that facilitates optical signal propagation between an MOF fiber and a different optical fiber.

The secondary reference, Van Der Tol, discusses a polarization-manipulating device ("polarization splitter") configured such that, with reference to FIG. 2 thereof:

> "… a signal (arrow I) coming in via the monomodal input guide 21 and having an unknown polarization, in general containing a TE_{00} component and a TM_{00} component of arbitrary relative strength and an arbitrary relative phase, will be split into a signal (arrow O1), going out via guide 28 and containing (virtually) exclusively the TE_{00} component and a signal (arrow O2), going out via guid 29 containing (virtually) exclusively the TM_{00} component." (col. 8, line 68 – col. 9, line 9).

Thus, as understood, the purpose of Van Der Tol's polarization splitter is to split an incoming optical signal provided on a first waveguide 21, and to provide two respective outputs onto two different waveguides 28 and 29 with different polarizations. However, none of Van Der Tol's input or output guides 21, 28, or 29 are "microstructured optical fibers" as recited in Claim 1 as amended. Indeed, none of the input/output guides 21, 28, or 29 are even optical fibers, but rather, as understood, are planar lightwave devices. Although the propagation from one end A to the other end E of Van Der Tol is characterized as "adiabatic," there is no teaching or suggestion that such adiabatic transition is, would, or could be implemented for a source or destination waveguide that is a "microstructured optical fiber" as recited in Claim 1, and it is readily apparent that the Van Der Tol device as disclosed therein could not be so operative. It is respectfully submitted that any combination of DiGiovanni and Van Der Tol to arrive at the optical device of Claim 1 as amended would constitute a hindsight reconstruction that uses the claim itself as the template for construction. It is therefore respectfully submitted that Claim 1 as amended is patentable over the cited references.

Claims 2-8

Claims 2-8 are submitted to be allowable at least for the reason that they depend from an allowable base claim. Moreover, with respect to Claim 2, no teaching or suggestion could be found in the cited references that both the source and destination optical fibers be microstructured optical fibers, which would be necessitated where said second and fourth cross-sectional material patterns are recited to "each comprise a void pattern."

With regard to Claims 4-5, no teaching or suggestion could be found in the cited references regarding the manner and dimensions for which an adiabatic transition from an MOF to a solid optical fiber (SOF) would be achieved. For example, in Claim 5 it is recited that the void *sizes* "remain constant over the axial distance of the transition region", while the *number of voids* decreases gradually to zero from one end of the optical device to the other to achieve the adiabatic transition. Neither DiGiovanni nor Van Der Tol disclose or suggest these kinds of structural transitions, nor those of an other embodiment as recited in Claim 7 in which the void *sizes* change gradually to zero. With

respect to Claim 8, there is no teaching or suggestion in the cited references for a linear change in the "material refractive index profile" from one end to the other.

Claims 9 and 10-18

For reasons similar to those presented for Claims 1 and 2-8 *supra*, it is respectfully submitted that Claims 9 and 10-18 are also patentable over the cited art.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the attorney of record, Ivan S. Kavrukov, at (212)-278-0400.

Entry of this amendment and allowance of this application are respectfully requested.

Respectfully Submitted,

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EXHIBIT A

In the Abstract

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A microstructured optical fiber (MOF) transformer element for connecting an MOF [a microstructured optical fiber (MOF)] to a solid optical fiber (SOF), and method of fabrication thereof, is described [. The transformer element comprises] comprising an MOF-matched first end, an SOF-matched second end, and an adiabatic transition region therebetween. The adiabatic transition region comprises void patterns that gradually change [over its length] from an MOF-matched void pattern at the first end to a solid cross-section at the second end. The [optical material of the] transformer element has a refractive index profile designed to cause the adiabatic transition region to have a core size and effective refractive index profile matching those of the MOF at the first end, and matching those of the SOF at the second end, with slow, incremental changes in the core size and effective refractive index profile between the first and second end. [The] A preferred fabrication method [comprises the steps of generating a plurality of] generates component wafers representing longitudinally consecutive portions of the [perform] preform, and [then bonding the component wafers] bonds them together. [A component wafer is created by removing a thin slice from a conventionally-made preform and applying a chemical-mechanical polishing process to the slice until the desired thickness is reached. Lithographic techniques analogous to those used in semiconductor fabrication are used to form the void regions in the preform. Several alternative preferred embodiments for forming component wafers, including those using chemical vapor deposition, lithographic, and/or flame hydrolysis techniques, are described.]

In the Claims

1. (Once Amended) An optical device for coupling a first optical fiber having a first cross-sectional material pattern to a second optical fiber having a second cross-sectional material pattern different than the first, the first optical fiber being a microstructured optical fiber and the first cross-sectional material pattern being a void pattern, comprising:

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a first end [adapted to connect] for connecting to the first optical fiber and having a third cross-sectional pattern substantially matched to said first cross-sectional material pattern;

a second end [adapted to connect] for connecting to the second optical fiber and having a fourth cross-sectional pattern substantially matched to said second cross-sectional material pattern; and

a transition region between said first and second ends, said transition region being designed and configured such that an optical signal entering said first end from said first optical fiber propagates adiabatically to said second end;

whereby reflections of the optical signal back into the first optical fiber are avoided.

2. (Once Amended) The optical device of claim 1, wherein said [first,] second, third, and fourth cross-sectional material patterns each comprise a void pattern.

Exhibit B

Abstract

A microstructured optical fiber (MOF) transformer element for connecting an MOF to a solid optical fiber (SOF), and method of fabrication thereof, is described comprising an MOF-matched first end, an SOF-matched second end, and an adiabatic transition region therebetween. The adiabatic transition region comprises void patterns that gradually change from an MOF-matched void pattern at the first end to a solid cross-section at the second end. The transformer element has a refractive index profile designed to cause the adiabatic transition region to have a core size and effective refractive index profile matching those of the MOF at the first end, and matching those of the SOF at the second end, with slow, incremental changes in the core size and effective refractive index profile between the first and second end. A preferred fabrication method generates component wafers representing longitudinally consecutive portions of the preform, and bonds them together.

Claims

1. An optical device for coupling a first optical fiber having a first cross-sectional material pattern to a second optical fiber having a second cross-sectional material pattern different than the first, the first optical fiber being a microstructured optical fiber and the first cross-sectional material pattern being a void pattern, comprising:

a first end for connecting to the first optical fiber and having a third cross-sectional pattern substantially matched to said first cross-sectional material pattern;

a second end for connecting to the second optical fiber and having a fourth cross-sectional pattern substantially matched to said second cross-sectional material pattern; and

a transition region between said first and second ends, said transition region being designed and configured such that an optical signal entering said first end from said first optical fiber propagates adiabatically to said second end;

whereby reflections of the optical signal back into the first optical fiber are avoided.

2. The optical device of claim 1, wherein said second, third, and fourth cross-sectional material patterns each comprise a void pattern.

3. The optical device of claim 1, wherein said first and third cross-sectional material patterns each comprise a first void pattern, and wherein said second and fourth cross-sectional material patterns each comprise a solid pattern.

4. The optical device of claim 3, said first void pattern being characterized by void sizes, void center-to-center spacings, and a number of voids, wherein said transition region comprises a transition sequence of void patterns that changes gradually from said first void pattern at said first end to said solid pattern at said second end over an axial distance that is at least ten thousand times longer than a wavelength of the optical signal.

5. The optical device of claim 4, said transition sequence also being characterized by void sizes, void center-to-center spacings, and a number of voids, wherein the void sizes of said transition sequence remain constant over the axial distance of the transition region, while the number of voids of said transition sequence decreases gradually to zero at said second end.

6. The optical device of claim 5, said first and second fibers each comprising cores, said transition region comprising a corresponding core that tapers in size from a size of said first fiber core at said first end to a size of said second fiber core at said second end.

7. The optical device of claim 4, wherein the void sizes of said transition sequence decrease gradually to zero at said second end.

8. The optical device of claim 7, wherein said transition region core has a material refractive index profile selected such that an effective refractive index of said transition region core is equal to an effective refractive index of said first fiber core at said first end,

varies linearly with axial distance from said first end, and is equal to a refractive index of said second fiber core at said second end.

9. A microstructured optical fiber transformer element for coupling a microstructured optical fiber (MOF) to a solid optical fiber (SOF), comprising:

an MOF-matched end having a void pattern and an effective refractive index profile substantially similar to a void pattern and an effective refractive index profile of the MOF;

an SOF-matched end having a solid cross-section and a refractive index profile substantially similar to a refractive index profile of the SOF; and

a transition region connecting said MOF-matched end to said SOF-matched end, said transition region being designed and configured such that a light signal entering said MOF-matched end or said SOF-matched end propagates adiabatically to the other end.

10. The microstructured optical fiber transformer element of claim 9, wherein said transition region has a longitudinal length that is at least ten thousand times a wavelength of the light signal.

11. The microstructured optical fiber transformer element of claim 9, said transition region comprising a core region having a size substantially similar to that of a core region of the MOF at said MOF-matched end, said core region having a size substantially similar to that of a core region of the SOF at said SOF-matched end.

12. The microstructured optical fiber transformer element of claim 11, said transition region comprising a cladding region having a size substantially similar to that of a cladding region of the MOF at said MOF-matched end, said cladding region having a size substantially similar to that of a cladding region of the SOF at said SOF-matched end.

13. The microstructured optical fiber transformer element of claim 12, said MOF void pattern being characterized by void sizes, void center-to-center spacings, and a number of voids, said transition region having a transition sequence of void patterns that

incrementally changes from said MOF void pattern at said MOF-matched end to a solid cross-section at said SOF-matched end.

14. The microstructured optical fiber transformer element of claim 13, said transition sequence being characterized by void sizes, void center-to-center spacings, and a number of voids, wherein said void sizes remain constant over the axial distance of the transition region, while said number of voids decreases gradually to zero at said SOF-matched end.

15. The microstructured optical fiber transformer element of claim 13, said transition sequence being characterized by void sizes, void center-to-center spacings, and a number of voids, wherein said void sizes adiabatically decrease from said MOF void sizes at said MOF-matched end to zero at said SOF-matched end.

16. The microstructured optical fiber transformer element of claim 13, wherein a material refractive index profile of said transition region core region varies with axial distance from said MOF-matched end such that an effective index of refraction of said transition region core region changes linearly from an effective index of refraction of said MOF core region at said MOF-matched end to an index of refraction of said SOF core region at said SOF-matched end.

17. The microstructured optical fiber transformer element of claim 15, said MOF core being larger than said SOF core, wherein said transition sequence comprises core void center-to-center spacings that correspond to said MOF core void center-to-center spacings at said MOF-matched end, decrease proportionally with distance from the MOF-matched end, and correspond to said SOF core size at said SOF-matched end.

18. The microstructured optical fiber transformer element of claim 17, wherein said transition sequence comprises cladding void center-to-center spacings that correspond to said MOF cladding void center-to-center spacings at said MOF-matched end, radially stretch with distance from the MOF-matched end to occupy an increasing cladding area, and correspond to said SOF cladding size at said SOF-matched end.